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ABSTRACT

This review of the role of the metaphor in instruction begins with a brief description of historical thinking on the subject. Modern views of the metaphor as a psychological mechanism rather than just a figure of speech are then presented, with emphasis on reasons why metaphors should be helpful in education. It is noted that the hypothesis that metaphor allows a transfer of meaning from something well-known to something less well-known is supported by contemporary theorists, who further suggest that the transfer of structures from one domain to another may involve the creation of new cognitive structures. Brief discussions of the substitution theory view and the interaction view include the limited role ascribed to metaphor in education by both substitutionists and interactionists. The attitudes of scientists toward metaphor are then described, and it is noted that investigators during the 1960s began to recognize the apparent importance of non-literal imagery to the explanatory aspects of scientific theory. Psychological studies of metaphor comprehension in the context of child development and processing by mature subjects are reviewed, as well as research on the time needed to process metaphor under various conditions and the memorability of metaphorical language. Instructional uses of metaphor are also discussed in the context of the communication process. The paper concludes with a discussion of the possibility of theoretical integration of metaphors into instructional design theory, Reigeluth's elaboration theory, and Keller's motivational theory. (67 references) (BBM)

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Title:

Metaphor and Instruction

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Metaphor and Instruction

Instruction is, at least in part, concerned with assuring that students gain knowledge. The canonical case of knowledge acquisition is science. Scientists, faced with a confusing universe, attempt to order that confusion with propositions which explain and sometimes predict. Where do such propositions come from? In recent years, writers such as Bohm and Peat (1987) have suggested that metaphor lies at the heart of scientific insight. They write that, "The essential point...is that metaphors can have an extraordinary power, not only to extend the thought processes of science, but to penetrate into as yet unknown domains of reality, which are in some sense implicit in the metaphor" (p. 41).

Historical background

What is a metaphor? How do metaphors differ from similes, analogies, and models? These are not new questions but they have not been completely answered even today. The study of metaphor dates back to the ancient Greeks. Aristotle made the well-known distinction between similes and metaphors. According to Aristotle (1958), "Metaphor consists in giving [a] thing a name that belongs to something else..." (p. 368), while a simile is a comparison between two things using the words like or as. Analogies, according to Aristotle, are an explicit mapping of one relationship onto another. Models, a relatively new form of expression, are concrete and valid representations of the structure of a device or system (Mayer, 1989). Metaphors, similes, analogies and models all share some qualities; they all evoke some kind of comparison; they all use one thing to shed light on another; and they all rely ultimately on language. Metaphors differ from similes, analogies, and models in some ways, however. First, in using one name for another, as Aristotle would put it, one comes to see one thing in terms of another. Thus, users of graphic computer interfaces who put "files" in "folders" may come to actually believe that the files are in folders. Another aspect of metaphors is that ground of the comparison may be difficult to make explicit. The metaphor "Chevrolet is the heartbeat of America", although readily understandable, is not readily explicable. Additionally, metaphors must relate things that are not overtly similar. One can say that Math 101 at the University of Kansas is like (or analogous to) Math 1 at some other university, but one cannot say Math 101 is a metaphor for Math 1. The final point to be made about metaphors is that they often have a certain affective power that is usually missing from similes, analogies, and models. Consider "Chevrolet is like the heartbeat of America." Most people would agree that it is weaker than the metaphor.

As was mentioned above Aristotle was one of the first to discuss metaphor. There are two points to be made about Aristotle's treatment of metaphor. The first is that metaphor is seen as a figure of speech, not a cognitive phenomenon. The second is that, for Aristotle, metaphor still had an important function. In the Rhetoric (1958) Aristotle asserts that "We learn above all from metaphor" (p. 89) and that for the poet "the greatest thing by far is to have a command of metaphor" (p. 87). This point is noteworthy because not all thinkers believe metaphor is important. The Aristotelian position yielded to the pressure of empiricism and logical positivism (Johnson, 1980), and was largely discounted through the mid-1960's.

The alternate position, attributable to Plato, is that metaphor is essentially a frill or deception. This view interprets metaphor as a rhetorical device and therefore an

imprecise and often misleading tool (Hoffman & Honeck, 1980; Johnson, 1980). This position is typified in John Locke's (1961) opposition to figurative language on the grounds that:

> if we would speak of Things as they are, we must allow that all the Art of Rhetorick, besides Order and Clearness; all the artificial and figurative application of Words Eloquence hath invented, are for nothing else but to insinuate wrong Ideas, move the Passions, and thereby mislead the Judgment; and so indeed are perfect cheat: And therefore, however laudable or allowable Oratory may render them in Harangues and popular Addresses, they are certainly, in all Discourses that pretend to inform or instruct, wholly to be avoided; and where Truth and Knowledge are concerned, cannot but be a great fault, either of the Language or Person that makes use of them. (pp. 507-8)

Modern views

The modern study of metaphor can be traced to the work of I. A. Richards (1936). Richards felt that verbal metaphor was a product of a more basic psychological mechanism, rather than just being a figure of speech. Richards contributed the terminology (e.g. tenor, vehicle, and ground) which remains in use today in much research, although often in a different sense from Richards' usage. In a metaphor such as, "Man is a wolf." , man is the tenor (or topic as most modern writers prefer), wolf is the vehicle, and the idea that the men share some qualities with wolves is the ground of the metaphor.

Max Black held a similar view of metaphor to Richards. However, Max Black (1979) expanded Richards' position and held that every metaphor mediates a structural correspondence between a primary subject and a secondary subject which are to be regarded as systems of belief rather than as things. The metaphor results in an interaction between the primary and secondary subject which creates a new understanding of both.

Following upon the work of Richards and Black, Lakoff and Johnson (1980) demonstrated convincingly that ordinary language is systematically riddled with metaphor: "We use ontological metaphors to comprehend events, actions, activities, and states" (p. 30); and ". . . we typically conceptualize the nonphysical in terms of the physical . . ." (p. 59). The importance of this book was that it demolished the notion that metaphor is some kind of special language, limited to literary applications. It became obvious that not only is metaphor more than a figure of speech, but it is also a ubiquitous feature of human communication.

Given that metaphors have psychological importance it is not surprising that some felt they may also have educational importance. Ortony (1975) cited three reasons why metaphors should be helpful in education: they are vivid, they express the inexpressible, and they are informationally compact. The vividness hypothesis holds that metaphor presents information in a particularly concrete manner, thereby aiding retention. The inexpressibility hypothesis holds that some ideas which cannot be expressed literally can be expressed metaphorically. The compactness hypothesis holds that metaphors "chunk" information, increasing communicational efficiency.

A related part of Ortony's thesis is that metaphor allows a transfer of meaning from something well-known to something less well-known. Theorists such as Haynes (1975), Johnson (1980), and Petrie (1979) support this notion while further suggesting that the transfer of structures from one domain to another may involve the creation of

new cognitive structures. Black (1979) noted that, ". . . every metaphor may be said to mediate an analogy or structural correspondence" (p. 31), a position which supports the notion that metaphor mediates the transfer of knowledge from one domain to another. Whether or not this transfer of knowledge involves the creation of something new depends on the interactionist versus substitutionist point of view taken.

Theories of Metaphor

According to the substitution view, a metaphor is simply an elaborate way of stating something that could be stated literally. As a result a metaphor is viewed as no different from a simile or an analogy except that it is typically more abbreviated. To assert that, "Man is a wolf" is only an alternate, indirect way to suggest that man is vicious or predatory. The word "wolf" substitutes for the attributes vicious or predatory. Waggoner (1984) suggested that nearly all metaphor theorists are substitutionists, whether they identify themselves as such or not.

The interaction view of metaphor suggests that metaphor is more than a similarity which could be expressed by literal language (Richards, 1936; Black, 1962, 1978, 1979). Interactionists claim that metaphor actually creates a similarity that did not previously exist (Black, 1979). Although some psychologists have embraced interactionist views of metaphor (e.g., Tourangeau & Sternberg, 1981; Verbrugge, 1980), Waggoner (1984) has argued that in operationalizing their theories they more closely resemble substitutionists.

For educational purposes the substitution theory, in a strict sense, suggests that metaphor plays only a limited role (Green, 1979). Substitutionists assert that a metaphor only points out a similarity which could be expressed in other, more literal, words. If true, it would seem reasonable to simply present instructional information in literal form. However, because the distinction between substitution theory and interaction theory is not always maintained, even substitution theorists have advocated the educational benefits of metaphor (Ortony, 1975). Despite the growing respectability of metaphor as a cognitive phenomenon, the educational view of metaphor has been primarily Platonic: To teach metaphor as a literary device has been acceptable but to use metaphor as an educational tool has been equated with deception (Petrie, 1979) and has been described as unnecessary (Green, 1979; Miller, 1976).

Science and metaphor

The literal bias of educational empiricism has not always prevailed in the field of science. One person who implicitly recognized the value of metaphor was Leonardo Da Vinci. Winternitz (1967) described Da Vinci's obsession with metaphor and how it led to several inventions. In one instance, Leonardo compared the spine with its cords and muscles to the mast of a ship and recommended, as a pedagogical device, the replacing of muscles in models of the spine with thin cords to represent the lines of force. Thus Da Vinci demonstrated his understanding of the instructional value of the non-literal representation of a domain of knowledge.

During the 1960's, investigators began to recognize the apparent importance of non-literal imagery to the explanatory aspects of scientific theory. For example, Hempel (1965) showed that some theoretical terms cannot be reduced to literal observational statements. Thus the naive idea that science was based on the literal interpretation of data was weakened. Black (1962) and Hesse (1966) refined the relationship between

scientific theories, models which instantiate those theories, and the metaphors which express the relationship between theories and models.

Miller (1984) described the 19th century German scientific tradition in which Einstein was educated: "The matrix of science, philosophy, and technology in which Einstein was educated and worked placed a high premium on visual thinking, a mode of thought that he preferred for creative scientific thinking" (p. 48). Einstein's earlier education included attending a Pestalozzian school. Central to Pestalozzi's educational philosophy was the concept of Anshauung which referred to a customary intuition or image (Walsh, 1952). For example, in the famous 19th century discussions of the lines of electromagnetic force, ". . . Anshauung refers to the intuition through pictures formed in the mind's eye from previous visualizations of physical processes in the world of perceptions; Anshauung is superior to viewing merely with senses" (Miller, 1984, p. 110). For Pestalozzi the meaning of Anshauung varied from perceptions of the senses to the form imposed on reality by the mind. Educationally, this meant that perceptions should always precede words in education. Einstein went from this Pestalozzian environment into the 19th century German scientific community, where, coincidentally, Anshauung was also a central concept. Though Anshauung is generally considered to be untranslatable but from the previous quotation it is apparent that metaphoric image would approximate the meaning.

The importance of metaphorical imaging cannot be underestimated. One of Einstein's famous Gedanken experiments, which led to the theory of relativity, consisted of imagining himself traveling alongside a light wave. This is a clear metaphoric image, formed completely within the tradition of Anshauung, which allowed a radically new interpretation of reality. Nor was this an isolated case, as Einstein used similar images to arrive at other conclusions, such as the gravitational bending of light.

Empirical studies

There are two areas of psychological study concerned with metaphor comprehension. The first attempts to elucidate developmental questions. The second deals with metaphor processing by mature subjects.

A sizable body of research on the developmental aspects of metaphor comprehension and production was reviewed by Ortony, Reynolds, and Arter (1978). Its relevance to instruction should be obvious. If metaphors are not understood, or understood with difficulty, by children then their instructional utility will be minimal. Ortony et al. found that the early developmental studies were plagued with the usual difficulties in research on children. For some studies like Billow (1975) and Winner, Rosenthiel and Gardner (1976) the stimulus materials were criticized for being obscure or atypical. In general, however, the studies showed that children have some ability to comprehend metaphor although it increases with age. Evidence of metaphor production was obtained for children as young as five years old (Billow, 1975) and for some tasks, at least, children's performance was as good as that of adults (Gentner, 1977). In more recent research, Winner, McCarthy, and Gardner (1980) also found strong evidence of use of metaphor in young children and found sequential steps in metaphor development, with production of action-based metaphors preceding the production of perception-based metaphors. Pollio and Pickens (1980) found a similar developmental pattern; recognition first followed by paraphrase and then explication. However, Waggoner, Messe and Palermo (1985) reported that children as young as 7 years of age correctly interpret metaphors when embedded in story schemata, suggesting that young children's inability comprehend metaphors may be experimental artifacts due to

contextual problems. Recent reviews of the literature have concluded that, although metaphoric comprehension may be confounded by various contextual, linguistic, and developmental factors (Vosniadou, 1987), children as early as the pre-school years have the competence to understand metaphors (Winner, 1988).

A second type of research has focused on the time needed to process metaphor under various conditions. The goal of these studies has been to determine whether or not metaphors are more difficult to process than literal language. The hypothesis is that the apparently anomalous nature of metaphorical language should require additional processing and therefore reaction times should be slower. Two-process theories derive from Kintsch (1974). On the other hand, if metaphor is not anomalous, comprehension time should be approximately the same as literal language.

In general metaphor has not been found to increase processing time. Ortony (1980) reported that processing time interacts with context: Where sufficient context exists, metaphors are comprehended as rapidly as literals. Inhoff, Lima, and Carroll(1984) supported this position noting that, ". . . even in circumstances in which few schemata have been activated by the time the target sentence is read, metaphors can be comprehended about as easily as literals" (p. 564).

Harris, Lahey, and Marsalek (1980) reported that metaphors can be processed effectively even under heavy attentional disadvantages. Using an incidental-learning paradigm, subjects were asked to listen to sentences containing metaphors, dead metaphors, and literal statements. A distracting task (counting the words in each sentence) was embedded between sentences. On a forced-choice recognition test, nonmetaphors were recognized significantly less often than metaphors and dead metaphors. Thus research suggests that, for adults, metaphorical language is no more difficult to comprehend and recognize than literal language. In fact, Hoffman and Kemper (1987) have argued that the reaction time studies cannot resolve the two-process question, but that most of the evidence supports that idea that there is no special metaphor comprehension process.

The memorability of metaphorical language has also been studied. Harris, Lahey, and Marsalek (1980) reported that metaphors are sometimes easier to remember than literal statements. Reynolds and Schwartz (1983) reported greater memorability for metaphorically stated conclusions rather than literally worded ones. Thus, in certain instances metaphors appear to be easier to remember than literal sentences.

In conclusion, studies have indicated that young children have metaphoric competence, although this may be interfered with by a variety of factors. In adults, there is no evidence that metaphors are more difficult to comprehend than literal language and there is evidence that, under some conditions, metaphors are more memorable than literal statements.

Instructional uses of metaphor

Instruction is a special case of communication where the potential of metaphor appears formidable. Norman, Gentner, and Stevens (1976) noted that:

> One important component of the process of learning and teaching is that of communication. The teacher has the task of conveying a particular knowledge structure to the student. The learner has the task of deducing just what structure is intended by the teacher, as well as the additional task of adding the new information to his previous knowledge in such a way that it can be referred to and used at a later time. Many of the problems of learning and teaching can be understood as problems in this communication process. (pp. 186-7)

Problems in the communication process may be traced to problems in the medium or problems in the encoding and decoding process. For example, Bonar and Soloway (1985) have shown that many computer programming errors may be traced to the inaccurate mapping of novice natural language knowledge onto a programming language. Students mistakenly overextend the metaphor of language (as in computer language) and make numerous unwarranted assumptions. This indicates the tendency of students to supply their own metaphors when none are explicitly provided by the teacher. Carroll and Thomas (1982) argued that the application of metaphors to new knowledge domains by students is inevitable and that not all metaphors are equally efficacious, therefore appropriate choice of metaphors is crucial.

The casual use of metaphor by teachers is probably more common than often assumed. However, little research has been reported to validate the use. In one study, Wilson, Gaff, Dienst, Wood and Barry (1975) found that an important characteristic of influential teachers is the frequent use of analogies. For the most part, systematic attempts to use metaphor pedagogically are rare.

There are at least three way in which metaphor can be used to influence instruction. The first is the teacher's (or instructional designer's) conception of the educational process and his/her role in that process. The second is the student's conceptual of his/her role. The third is in the mediation of the content itself.

Numerous writers have commented on the fact that the metaphors we adopt for instruction can influence how we function as teachers or instructional designers (Egan, 1989; Heitland, 1981; Kloss, 1987; Marshall, 1988; Moore 1987; Munby, 1986; Tom, 1984). A particular case of this can be found in the "container and conduit" metaphor of mind and language (Lakoff and Johnson, 1980; Mosenthal, 1987; Reddy 1979). If we think of language as "containing" meaning which it "transmits" to a "data storage device" like long- or short-term memory our lessons will assume certain characteristics. On the other hand, if we think of brain faculties as muscles to be exercised and strengthened thereby, our instructional approaches will assume other forms. Some metaphors may be adopted unthinkingly, based upon the general intellectual assumptions of our time. Others may be adopted deliberately. In any case it seem obvious that if we think of ourselves as "delivering" instruction, or coaching, or acting as facilitators, or serving as travel agents, our instructional strategies will bear the stamp of our metaphors.

The second way in which metaphors can influence instruction is in forming the student's unconscious or meta-cognitive conception of his or her role in the instructional process. One program which makes deliberate use of metaphor is Gordon's Synectics (1961, 1971) which treats metaphor as a metacognitive strategy and trains students in this strategy. The Synectics curriculum involves training in personal analogy, direct analogy, and compressed conflict. Personal analogy connects mentally oneself to the device or mechanism under study and imagining the results. Direct analogy is the borrowing of natural solutions for engineering problems. The idea of caissons, for example, came directly from the observation of shipworms. Finally, compressed

conflict derives from the deliberate juxtaposition of incompatibles, such as burning ice, in order to force the thinker to go beyond the assumed domain of the problem. Sanders and Sanders' (1984) course in teaching creativity through metaphor is derivative from Gordon's Synectics. The Synectics curriculum has not been subject to rigorous evaluation.

A more controlled set of studies was performed by Paris and his colleagues (reported in Paris, Wixson, and Palincsar, 1986). Paris et al. used metaphors to teach reading strategies. Metaphors such as "reading detectives" and "planning reading trips" were used to concretely structure metacognitive strategies. In addition to supporting reading skills, these metaphors stimulated group discussions about reading and thinking. Students exposed to this metaphorical curriculum exhibited significant improvements in reading awareness and use of reading strategies.

The third way in which metaphors can be used is to mediate content itself. If metaphors express the inexpressible, are more vivid or, chunk information they should have positive effects on comprehension and memory. Pearson, Raphael, TePaske, and Heyser (1981) found that metaphoric sentences were recalled better than literals when placed in unfamiliar passages, although overall recall was unaffected. Reynolds and Schwartz (1983), as reported above, obtained contrary results. They found that metaphors placed at the end of prose passages were recalled better than literal counterparts and that overall recall was also improved. Reynolds and Schwartz's metaphors served as summarizers which may explain their better overall results. Hayes and Mateja (1981) found that metaphors embedded in text produce greater engagement than comparative organizers. Subjects who read a passage with embedded metaphoric allusions produced more inferences and less incorrect information than subjects given a comparative organizer first. Because this same result was found with entirely different materials in an earlier study (Hayes & Tierney, 1980) they argued that the effect is reliable. In spite of these results, Becker and Carrier (1985) and Yarbrough and Gagné (1987) found that the insertion of multiple metaphors into a text did not increase learning. Both of these studies used unrelated metaphors and thus do not speak the effect of a single systematic metaphor used to structure a body of content.

There is not a body of literature indicating that metaphors, used haphazardly, will increase learning. However, metaphors used systematically do have positive effects on learning and retention of content.

Theoretical integration

General guidelines for the use of metaphors have been reported elsewhere (Carroll and Thomas, 1982), but there is also the possibility of theoretical integration of metaphors into instructional design theory, Reigeluth's elaboration theory (Reigeluth and Stein, 1983) and Keller's motivational theory (Keller, 1983) both include metaphors (as a kind of analogy) into their prescriptions. Both authors seem to regard metaphors as adjunct aids to instruction rather than having a central function.

An alternative view is to see the use of metaphor as a function of the degree of abstractness of the canonical case of the content being taught. Reigeluth calls this canonical case an epitome and this serves as a base for his elaboration theory. For Reigeluth an epitome consists of a small number of ideas that are most basic or fundamental to the particular type of content. In the case of a conceptually based biology course an example of an epitome would be the animal phyla. For a theoretical course such as economics, the principle of supply and demand would be an epitome. Reigeluth gives no example of an epitome for a procedural course like statistics. The essential issue here is whether a literal epitome is the preferred treatment under all

conditions. Since the comprehensibility of an example depends upon the degree to which its crucial characteristics are perceptually salient or not, it would seem that there must be cases in which the abstractness (or at least the unobservability) of the crucial features of the example would render it less tha useful. As a simple case consider learning to ski. The crucial characteristics of body movement are not necessarily external. A skilled skier must hold an inner model of correct posture, etc. A teacher of mine once described this ski posture as holding a basketball in your lap rather than pointing out the correct stance in literal terms, which an epitome would require. Similarly in the Paris studies above, children were told to think of themselves as detectives. Presenting good reading strategies in literal terms to children would require the comprehension of exceedingly abstract ideas. One can easily imagine that in statistics, economics, and biology, the degree to which a literal epitome would facilitate learning would depend upon the degree to which the students could assimilate abstraction from an example.

Thus, as a hypothesis, one could modify elaboration theory in this way. If the canonical case of the content is relatively concrete or salient to the student, then use an epitome to begin a course. On the other hand, if the canonical case is abstract or obscure, from the student's point of view, then use a metaphor to introduce the content.

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